



Article Title: MPPT of Solar Using Mid-Point Tracking Method

MPPT of Solar Using Mid-Point Tracking Method

Abisha R¹, Merry Guisa J²

¹Assistant Professor, EEE, Faculty, Narayanaguru College of Engineering.

²Professor, EEE, Faculty, St. Xaviers Catholic College of Engineering.

ABSTRACT

A Maximum Power Point Tracking or Tracker (MPPT) is a high efficiency system that extracts the maximum power output from a solar cell or an array of photovoltaic (PV) cells. Normally the solar power systems efficiency is less. To improve its efficiency, solar power systems are usually equipped with the function of MPPT. The work presented in this paper concerns the designing and implementation of a photovoltaic system (PV) provided with an MPPT control. More particularly, the utilization of a buck converter for controlling photovoltaic power using Maximum Power Point Tracking (MPPT) mechanism was presented. First the photovoltaic module is analyzed using SIMULINK software. In this project the buck converter was used along with a MPPT control. The MPPT is responsible for extracting the maximum possible power from the photovoltaic and feed it to the load via the buck converter which steps down the voltage to the required magnitude. The algorithm utilized for MPPT was the three-point weighting that incorporates mid-point tracking. The system was designed and simulated in MATLAB. Both the buck converter and the solar cell are modelled using Sim- Power Systems blocks. Especially, the waveforms of MPPT and Photo voltaic have been presented.

Keywords: Weighting machine, controller, buck converter, MPPT.

1 Introduction

Sun is the major source of all forms of energies. The distance from the earth to sun is 1.495×10^{11} m. The solar radiations are measured with the help of Pyranometer, Pyrliometer and a Sunshine Recorder. Solar energy can be utilized directly in two ways:

1. By collecting the radiant heat and using it in a thermal system.
2. By collecting and converting it directly to electrical energy using Photovoltaic system.

Solar thermal system uses solar thermal collectors. The collectors absorb the solar energy and convert it into heat. Solar collectors are classified as, Flat plate collectors, Modified flat plate collectors, Linear Fresnel lens collector, Central tower receiver etc... Normally the solar power systems efficiency is less. The output power of a photovoltaic system (PV) is nonlinear and it is affected by weather conditions. Therefore, the maximum power point tracking (MPPT) was invented to extract the maximum power from each PV arrays. PV cells have a single operating point where the values of the current (I) and Voltage (V) of the cell result in a maximum power output. Maximum power point trackers utilize various type of



Article Title: MPPT of Solar Using Mid-Point Tracking Method

control circuit and algorithms to search this point and thus to allow the converter circuit to extract the maximum power available from a cell.

2 Recent Works

Bourdoucen and Gastli (2006) presented an analytical model for PV panels and an array based on extracted physical parameters of solar cells is developed. This system has the advantage of simplifying mathematical modelling for different configurations of cells and panels without losing efficiency of PV system operation. The effects of external parameters, mainly temperature and solar irradiance have been considered in the modelling. Due to their critical effects on the operation of the panel, effects of series and shunt resistances were also studied. The developed analytical model has been easily implemented, simulated and validated using both Spice and Matlab packages for different series and parallel configurations of cells and panels. This proposed model is very useful for researchers and designers for quick and accurate sizing of PV panels and arrays. The same concept is explained in Rahmani and Fard (2011). In this a complete model of standalone PV array in simulink environment is presented. The PVA model has been developed by basic circuitry equations of a photovoltaic array, considering the effects of ambient temperature, solar radiation and natural specifications of the photovoltaic cell. Continuity of the texts.

3 General Block Diagram of Proposed

In (Fig.1.1), the Current and voltage from solar panel is measured with the help of current sensor and voltage sensor. The measured voltage and current are directly given to the dc-dc converter as well as the MPPT controller. For the practical cases, in the place of MPPT control microcontroller will be used. The algorithm for tracking the maximum peak point will be burned in it and it also has other features such as inbuilt ADC, sensors etc...DC-DC converter circuit is used in this system for converting the voltage from fixed into variable one and it helps to supply the variable load. It converts the voltage from unregulated into regulated one.

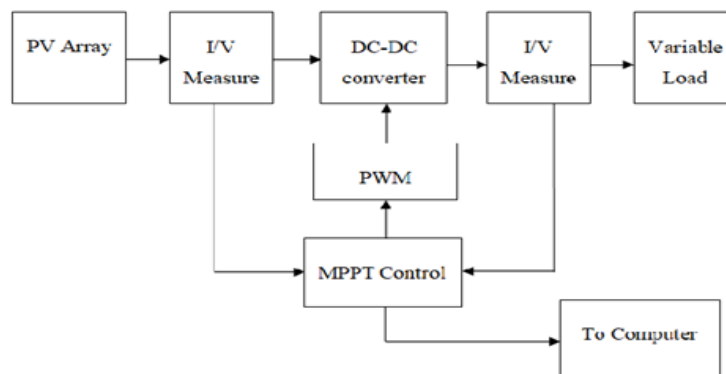


Figure 1: Basic Block Diagram



Article Title: MPPT of Solar Using Mid-Point Tracking Method

For simulation purpose, the algorithm for tracking maximum peak point will be designed inside the MPPT control. MPPT will set the reference voltage and that will be compared with the measured voltage from the converter circuit. The compared voltages will generate PWM signals and that will given to the gate of switch which is used in the converter circuit. From the converter circuit the output power will be supplied to the load. Depends on the application requirement various converters are chosen as buck, boost and buck-boost etc... For a standalone system, the battery which will be connected across the converter circuit and this helps to power the load during rainy days or when the sunshine's are not sufficient. For hardware tests, to view the output the control circuit will be interfaced with the computer.

3.1 Purpose of converter circuit in MPPT

Peak Power will be tracked by adjusting the impedance of the load. This is obtained by using an interface between the load and solar module and is shown in (Fig.1.2). DC-DC converter which serves as an interface between the PV module and the load. This is normally based on (SMPS).

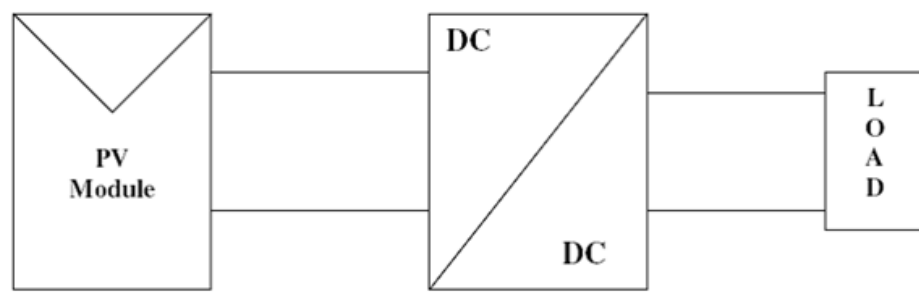


Figure 2: Peak Power Tracking

Depends on the application requirements various converters are chosen such as Buck converter, Boost converter and Buck-Boost converter. Among this, the Buck-Boost converter is most commonly used for Stand-alone as well as Grid-connected systems.

A Theory section should extend, not repeat, the background to the article already dealt with in the Introduction and laid the foundation for further work. In contrast, a Calculation section represents a practical development from a theoretical basis. Do not add extensive basic definitions or well-known theories, instead highlight theoretical background and its specific usages in view of your work only Figure 1.

3.2 Mathematical modelling

For a single cell,

$$I = I_{ph} - I_d - I_{sh} \quad (1)$$

$$I_{ph} = [I_{scr} + k_i (T - T_r)] \frac{S}{1000} \quad (2)$$

I_{scr} -short circuit current at a given temperature



Article Title: MPPT of Solar Using Mid-Point Tracking Method

Ki-temperature coefficient of short circuit current ($0.0017 \text{ A}^{\circ}\text{C}$)

T-cell temperature

T-reference temperature (273K)

S-solar irradiance

$$I_d = I_o \exp \left[\frac{q(V + I R_s)}{A K T} - 1 \right] \quad (3)$$

I_o -reverse leakage current

q- Electron charge ($1.602 \times 10^{-19} \text{C}$)

V-solar cell voltage

A-ideality factor

$$A = \frac{n K T N_s}{q} \quad (4)$$

n=1 for ideal diodes

3.3 Three Point Weighting Method

It uses a weighting generator and a response regulator. For speed up tracking response regulators are used. Weight generators are used for generating the control voltage V_{pc} . For getting correct control voltage the comparison of three best points are made. Within the weight generator, method of selecting the points will be done. The rules for selecting the points are as follows:

- Consider the three maximum points as A,B,C
- If $B > A$ add 1 to the weight.
- If $B < A$ then subtract 1 from weight.
- If $B = A$ add 1 to the weight and
- If $A = C$ then subtract 1 from the weight.

The input to weight generator will be $\frac{dP_{ab}}{dV_{ab}}$ & $\frac{dP_{ac}}{dV_{ab}}$.

The summed weight lies between -2 to 2, representing tracking from the right or from the left to MPP and is denoted in the following MPPT characteristics curve.

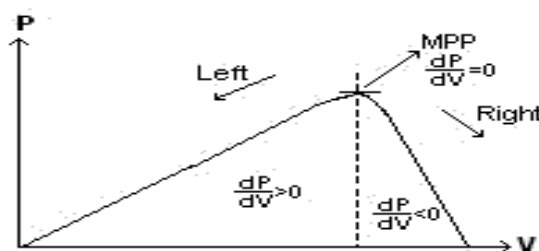


Figure 3: Characteristics of MPP



Article Title: MPPT of Solar Using Mid-Point Tracking Method

4 Results and Discussion

This section may each be divided by subheadings or may be combined. A combined Results and Discussion section is often appropriate. This should explore the significance of the results of the work, don't repeat them. Avoid extensive citations and discussion of published literature only, instead discuss recent literature for comparing your work to highlight novelty of the work in view of recent development and challenges in the field.

4.1 Preparation of Figures and Tables

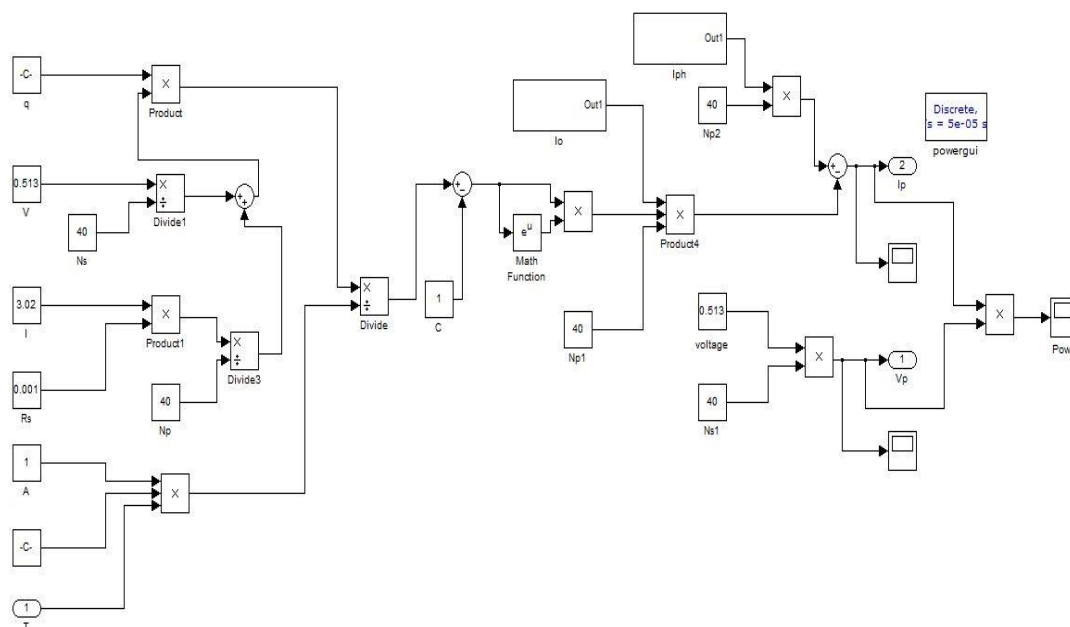
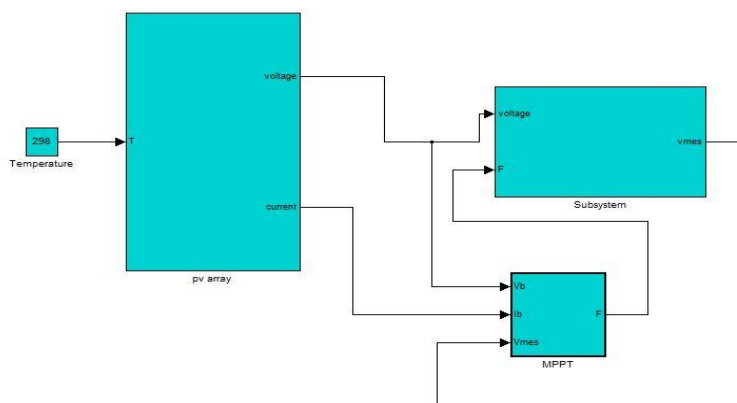


Figure 4: Design of Diode Current

4.2 Formatting Tables





Article Title: MPPT of Solar Using Mid-Point Tracking Method

The output current and voltage from the panel is given to the input of MPPT subsystem. The MPPT which sets the reference voltage as V_{pc} (control voltage) and that will be compared with the feedback voltage V_{pf} which is from the buck subsystem. Within the PWM signal control both the voltages will be compared and generates a PWM signal (denoted as G). This signal is applied to the gate of buck subsystem's IGBT switch. By this way the load connected in the converter circuit can be powered.

5 Conclusions

A renewable energy system is suitable for all applications. Especially, it can be used for residential as well as industrial purpose. As this is the standalone system, it can be used for powering homes. This project can increase the power efficiency of a PV cell drastically by the use of mid-point tracking technique. The system is a low cost system and can be implemented easily. The MATLAB software is applied in this work to pack and draw the collected data of solar cell characteristics. The future work is to implement the system using Fuzzy Logic Control.

References

1. Abd Kadir Mahammad; Sharifah Saon; Wong Swee Chee, "Development of optimum controller based on MPPT for photovoltaic system during shading condition," Malaysian Tech. Universities Conf. on Engineering & Technology (MUCET).
2. Abdulkadir M; Samosir A.S; Yatim; Year: 2013, "Modelling and simulation of a solar photovoltaic system, its dynamics and transient characteristics in LABVIEW," Inter J Power Electronics and Drive System (IJPEDS), Vol: 3, no: 2, pp. 185-192.
3. Benmessaoud MT; Zerhouni FZ; Zegrar M; et al, Year: 2010, "New approach modelling and a maximum power point tracker method for solar cells," computers and mathematics with applications, Vol: 60, pp. 1124-1134.
4. Bidyadhar Subudhi; Raseswari Pradhan, Year: 2013, "A comparative study on maximum power point tracking techniques for photovoltaic power systems," IEEE transactions on sustainable energy, Vol: 4, no: 1, pp. 1949-3029.
5. Bourdoucen H; Gastli A, Year: 2007, "Analytical modelling and simulation of photovoltaic panels and arrays," The journal of engineering research, Vol: 4, no: 1, pp. 75-81.